Maine Agricultural Experiment Station

BULLETIN No. 122. DECEMBER, 1905.

EXPERIMENTS IN ORCHARD CULTURE.

This bulletin contains the second report upon the progress of the special orchard experiments being conducted in Kennebec county, including culture and fertilization; orchard renovation; top-grafting; keeping quality as affected by culture; and cover crops.

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FIG. 9. In need of renovation—one-half barrel of fruit.

FIG. 10. The result of renovation—eight barrels of fruit. (See page 193.)

EXPERIMENTS IN ORCHARD CULTURE.

SECOND REPORT.*

W. M. MUNSON.

It has been estimated that the average value of the fertilizing elements taken from an acre of soil by apple trees during the period of 20 years, counting in ten crops of fruit, is approximately $377. Of this amount $147, or a little less than 39 per cent, is in the fruit; $160, or about 42 per cent, in the leaves; and $70, or about 19 per cent, in wood for the growth of the tree. The total amount of nitrogen, exclusive of that used in the growth of the trees, is about 1,300 pounds, of phosphoric acid 310 pounds, of potash 1,900 pounds per acre.

"To restore the potash alone as above, and that used by the growth of the tree, it would require 21.7 tons of high grade ashes containing 5 per cent potash. To restore the nitrogen would require 16.2 tons of a commercial fertilizer containing 5 per cent nitrogen." † In view of these facts, and also of the large amounts of fertilizing elements removed by crops of hay or grain, or by pasturing the orchard without giving extra feed to the animals, it is not strange that many of the orchards of Maine are deteriorating.

Of course, the fact should be taken into account that a portion of the material above referred to is returned to the soil in the way of fallen fruit and leaves and in the excrement of the animals, but with a liberal allowance for these returns the value of fertilizing elements actually removed from the soil during the period named will probably not fall short of $200, or $10 per acre per year.‡

As often urged in the publications of this Station, thorough tillage is one of the surest ways of rendering available the plant

* First Report see Bulletin 89, 1903.

† Roberts, Bul. 103, Cornell Exp. Sta.

‡ A recent valuable contribution to the literature of this subject is Bul. 265, N. Y. Agr. Exp. Sta. (Geneva).

food which is naturally contained in the soil. It may be added that apple trees are well suited to abstract this natural store of fertility; but there is a limit beyond which the tree cannot go without help.

In studying the methods of fertilizing orchards, the same general principles will apply as in the management of other farm crops. The essential constituents must be the same; but unlike ordinary farm crops, orchard crops do not give an opportunity for rotation. A certain amount of nitrogen is essential to the vigorous foliage upon which depends the life of the tree. Potash also is important, not only because it constitutes a large part of the ash of fruit trees and more than half of the ash of the fruit itself, but also, as suggested by Voorhees, because it forms salts with the well known acids. Lime, as also pointed out by Voorhees, "seems to strengthen the stems and woody portion of the tree, to shorten the period of growth and to hasten the time of ripening. Fruit trees growing on soils rich in lime show a stocky, sturdy, vigorous growth, and fruit ripens well; while those on soils which contain but little lime, particularly the clays, appear to have an extended period of growth, the result of which is that wood does not mature and the fruit does not ripen properly." *

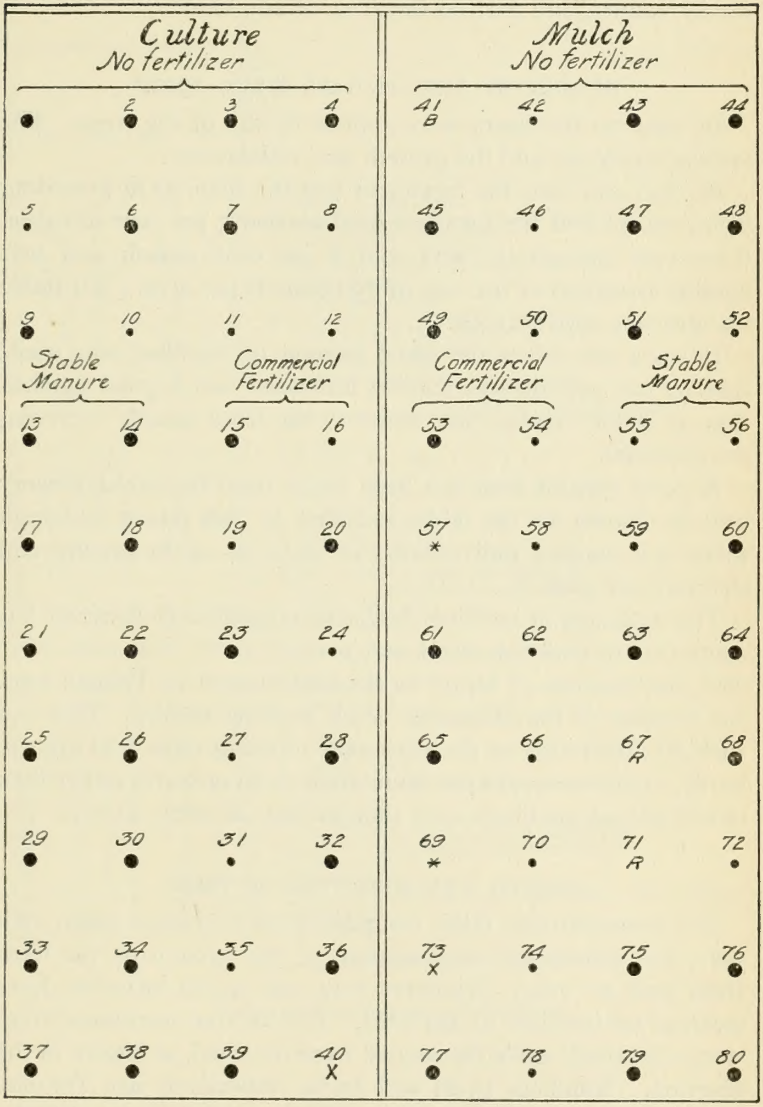
Culture and Fertilization.

In Bulletin 89, February, 1903, was published an outline of certain experiments relative to the culture and fertilization of orchards, together with such results as had been obtained. The work in question was conducted upon the farm of Mr. Chas. S. Pope, Manchester, Kennebec county, Maine. The interest evoked by these experiments, and the practical value of the demonstration of approved methods of treatment, have led to a considerable increase in the scope of the work and to the extension of operations with other growers. As in the past, much credit should be given to Mr. Pope for his faithful and hearty coöperation. The present report extends and supplements the report in Bulletin 89, and as little repetition is made as is consistent with clearness.

The comparative study of cultivation and mulch as treatment for a young bearing orchard is continued along the lines origin-

* Trans. Mass. Hort. Soc'y, 1896.

DIAGRAM OF THE ORCHARD.



Explanation of Diagram: The significance of the figures in the above diagram is as follows: ● = trees bearing in 1902; • = trees not bearing in 1902; × = vacancy; * = Bellflower tree; R = Roxbury Russet; B = Ben Davis.

ally planned. Forty trees are kept in cultivation and forty mulched; a part of each lot receiving complete fertilizer, part stable manure, and part no fertilizer of any kind.

HISTORY OF THE ORCHARD SINCE 1902.*

In 1902 no fertilizers were applied to any of the trees. The season was moist and the growth was satisfactory.

In 1903 and 1904 the treatment was the same as in preceding years except that the fertilizer used carried 3 per cent nitrogen, 6 per cent phosphoric acid, and 8 per cent potash, and was applied broadcast at the rate of 750 pounds per acre. No stable manure was used in 1904.

In 1905 two-thirds the usual amount of fertilizer was used; that is, 500 pounds was applied broadcast and a good application of stable manure was made to the trees usually receiving this material.

A good crop of fruit has been taken from the orchard every year as shown by the tables included in this report, although there is a marked individuality in the trees as to amount and character of fruit.

The weakness of seedling stocks, mentioned in Bulletin 89, has continued to manifest itself and several of the best trees have died, not because of injury to the Gravenstein or Tolman tops, but because of the inherently weak seedling trunks. This is a striking illustration of the advantage of using some well known, hardy, vigorous sort as the foundation of an orchard, rather than miscellaneous seedlings even though they be home grown.

GROWTH AND CONDITION OF TREES.

The accompanying table, compiled from field notes taken each year, will convey an exact account of the growth of the trees from year to year. Numbers 1-12 and 41-52 inclusive have received no fertilizer of any kind. But the first mentioned trees were cultivated, while the second were mulched, as shown in the diagram. Numbers 13-24 and 53-64 respectively are Tolman. The remainder are Gravenstein, with the exceptions noted in the column of "Remarks," and numbers 42, 46, 50, 66, 70, 74 and 78, which are Tolman.

* For a history of the orchard up to the close of 1902, see Bulletin 89.

Annual Growth of Trees in Cultivated Area.

Number of tree.	Growth in inches.*				Average growth in inches for four years.	Remarks.
	1902.	1903.	1904.	1905.		
1	6- 8	4- 6	4-6	3- 4	4 - 6	Hurt by cold, 1904-5.
2	6- 8	3- 5	1-2	0	3 - 4	Hurt by cold, 1904-5—nearly dead.
3	8-10	5- 7	2-3	2- 4	4 - 6	In excellent condition.
4	6- 8	5- 7	3-5	3- 6	4 - 6½	In excellent condition.
5	8-10	6- 8	4-6	6- 8	6 - 8	Top partly killed by cold, 1904-5.
6	4- 6	1- 2	0	0	1 - 2	Nearly dead.
7	8-10	3- 4	3-4	1- 3	4 - 5	Defective stock.
8	10-14	10-12	5-6	8-10	8 -10½	Injured a little in center of top.
9	8-10	4- 6	3-6	3- 6	4½- 7	Injured a little in center of top.
10	10-12	6- 8	6-8	8-10	8½- 9½	Vigorous; a good tree.
11	6- 8	4- 6	2-4	2- 4	3½- 5½	Defective stock.
12	10-12	7- 9	5-7	5- 7	8 - 9	Vigorous, healthy; a fine tree.
					5 - 6½	*Average annual growth for the twelve trees.*
13	8-10	4- 6	4-6	3- 4	5 - 6½	Vigorous.
14	8-10	8-10	5-6	7- 9	7 - 9	A very fine tree.
15	8-10	5- 7	1-2	6- 8	5 - 7	Doing well.
16	4- 5	8-10	7-9	7- 9	6½- 8	Doing well.
17	8-10	6- 8	4-6	6- 8	6 - 8	Doing well.
18	6- 8	10-12	7	9-10	8 - 9	Extra good tree.
19	6- 8	4- 6	2-3	0	3 - 4	Defective stock.
20	8-10	10-12	3-4	5- 8	6½- 8½	Good tree.
21	10-12	6- 8	6-7	8-12	7½- 9½	Extra good—both tree and fruit.
22	0	.....	.....	.....	.....	Dead. (Defective stock; died in 1903.)
23	10-12	10-12	4-6	8-10	8 -10	Extra fine tree.
24	6	10-12	2-3	4- 6	5½- 7	Good tree.
					6 - 8	*Average annual growth; eleven trees.*
25	6- 7	4- 6	6-8	8-10	6 - 8	Doing well.
26	6- 8	5- 7	4-5	6- 8	5 - 7	Doing well.
27	12	7- 9	4-5	1- 3	6 - 7	Half of tree dying.
28	4- 6	6- 8	2-4	1- 3	3 - 5	Dying.
29	6- 8	4- 6	3-6	4- 6	4 - 6	Doing well.
30	6- 8	3- 5	.....	0	3 - 4	Nearly dead.
31	10	8-10	3-6	4- 6	6 - 8	Injured in 1904; may be saved.
32	12	6- 8	4-6	5- 7	7 - 8	Good tree.
33	8	3- 5	5-7	1- 3	4 - 6	Good tree.
34	10	8-10	3-6	1- 3	5½- 7	Half of tree dying; trunk defective.
35	6- 8	5- 7	3	6- 8	5 - 6½	Half of tree dying; trunk defective.
36	8	5- 7	4-6	8-10	6 - 8	Doing well.
37	6- 8	6- 8	6	6- 8	6 - 7½	Doing well.
38	7- 8	4- 6	4-6	3- 5	4½- 6	One-third of tree Roxbury Russet. Doing well.
39	8	6- 8	5-7	6- 8	6 - 8	Good tree.
40	.....	.....	.....	.....	.....	Vacant.
					5 - 7	*Average annual growth; fifteen trees.*

* Fractions less than ½ are disregarded.

Annual Growth of Trees in Mulched Area.

Number of tree.	Growth in inches.*				Average growth in inches for four years.	Remarks.
	1902.	1903.	1904.	1805.		
41	8–10	8–10	4–6	8–10	7 – 9	*Ben Davis.* Doing well.
42	4– 6	5– 7	5–7	2– 4	4 – 6	
43	4– 6	3– 5	3–5	2– 4	3 – 5	
44	6– 8	6– 8	4–6	5– 7	5 – 7	
45	8–10	5– 7	3–5	1– 3	4 – 6	Center of top dying; defective trunk.
46	2– 4	4– 6	3–5	2– 4	3 – 5	
47	4– 6	4– 6	3–5	2– 4	3 – 5	
48	3– 6	3– 5	4–5	1– 3	3 – 5	
49	8–10	5– 7	5–6	4– 6	5½– 7	
50	2– 3	1– 3	2–3	1– 3	1½– 3	A weak tree.
51	6– 8	5– 7	4–7	2– 3	4 – 6	
52	2– 3	1– 3	3–5	1– 3	2 – 3	Half of top dying.
					3¾– 5½	*Average annual growth; twelve trees.*
53	6– 8	6– 8	1–3	4– 6	4 – 6	Doing well.
54	3– 5	4– 6	2–3	1– 3	2½– 4	Defective at base.
55	4– 6	6– 8	3–4	4– 6	4 – 6	
56	8–10	8–10	4–6	6– 8	6½– 8½	
57	10–12	7– 9	3–5	6– 8	6½– 8½	*Bellflower.* Fine tree. Excellent fruit in 1904; none 1905.
58	5– 6	7– 9	5–7	3– 5	5 – 7	Doing well.
59	4– 6	8–10	6–8	3– 5	5 – 7	Doing well.
60	5– 6	5– 7	3–5	4– 6	4 – 6	
61	6– 8	7– 9	4–6	3– 5	5 – 7	
62	4– 6	6– 8	3–5	4– 6	4 – 6	
63	8–10	8–10	4–6	4– 6	6 – 8	Particularly good tree.
64	10–12	10–12	5–7	4– 6	7 – 9	Particularly good tree.
					5 – 7	*Average annual growth; twelve trees.*
65	10–12	3– 5	3–5	3– 6	5 – 7	
66	2– 4	4– 6	1–3	1– 3	2 – 4	
67	10–12	8–10	4–6	6– 8	7 – 9	*Roxbury Russet.* Good tree.
68	8–10	8–10	6–8	5– 7	7 – 9	
69	12–14	8–10	4–6	6– 8	7½– 9½	*Bellflower.* Good crop of good fruit, both 1904 and 1905.
70	8	7– 9	3–5	8–10	6½– 8	
71	5– 7	5– 7	1–2	5– 7	4 – 6	*Roxbury Russet.*
72	6– 8	6– 8	5–7	6– 8	6 – 8	Doing well.
73	.....	.....	.....	.....	.....	Vacant.
74	1– 3	5– 7	1–2	1– 3	2 – 4	Good tree; 4½ bushels (Tolman), 1905.
75	6	6– 8	5–7	8–10	7 – 8	Fine tree; 9 bushels (Gravenstein), 1905.
76	6– 8	6– 8	6–8	6– 8	6 – 8	Doing very well.
77	10–12	6– 8	2–3	4– 6	5½– 7	Two-thirds of tree dead.
78	4– 6	5– 7	3–5	6– 8	4½– 6½	Doing well.
79	8–10	7– 9	5–7	8–10	7 – 9	Fine tree; 8½ bushels, 1905.
80	8–10	7– 9	6–8	8–10	7 – 9	Fine tree; 8¾ bushels, 1905.
					5½– 7½	*Average annual growth; fifteen trees.*

* Fractions less than ½ are disregarded.

Taking the orchard as a whole, there was an average annual growth of from three and one-half to eight inches. The unfertilized trees, in general, made less growth than did the fertilized trees, and the uncultivated than the cultivated. It is noticeable, however, that the Gravensteins which were mulched and fertilized averaged slightly better than those which were cultivated and fertilized. This is, no doubt, due to the partial killing of several of the trees on the cultivated ground. In nearly every case, however, it was the seedling stock which suffered and not the top, though of course the top soon followed. It is also true that the difference in elevation, if any, was in favor of the mulched trees; these being slightly lower, and possibly more moist. Such difference is very slight, however.

In Bulletin 89 the following table was published with the note that: "With a single exception, in which two trees had particularly good advantages, the growth on the mulched areas was less than on corresponding cultivated plats. On cultivated soil there was little increase in growth from the use of either manure or commercial fertilizer; while on the mulched land the growth was noticeably—two to five inches—greater as a result of adding plant food. These facts would indicate that there is enough plant food in the soil to produce a fairly satisfactory growth, if mechanical treatment is such as to render it available, and other plants are not allowed to rob the trees."

Variety.	Treatment.	Growth in inches; unfertilized.	Growth in inches; stable manure.	Growth in inches; commercial fertilizer.
Gravenstein	Cultivated	7½—9⅝ (12 trees)	7 —8 (8 trees)	8½—9 (7 trees)
	Mulched	5½—7½ (9 trees)	7 —8½ (6 trees)	10-12 (2 trees)*
Tolman	Cultivated	.....	6⅜—8⅓ (6 trees)	7 —8½ (6 trees)
	Mulched	2⅔—4½ (3 trees)	6½—8⅓ (6 trees)	5 —6½ (5 trees)

* These trees were in a slight depression and next to the cultivated area.

The record of succeeding years has justified the statement there made. For several years the unfertilized trees held their places both as to growth and as to yield, but during recent years the need of additional plant food has been manifest, even on the

cultivated areas. The average growth of the same trees for the past two years has been as follows:

Variety.	Treatment.	Growth in inches; unfertilized.		Growth in inches; stable manure.		Growth in inches; commercial fertilizer.	
		1904.	1905.	1904.	1905.	1904.	1905.
Gravenstein	Cultivated	3 —4⅜	3½—5	4 —5½	4 —6	3⅜—5½	4½—6½
	Mulched	3⅜—5½	2¼—4	5½—7½	7 —9	2½—4	3½—6
Tolman	Cultivated	....	.....	5¼—6¼	6½—8½	3 —4½	5 —7
	Mulched	3⅓—5	2 —4	4¼—6	4¼—6¼	3 —5	3 —5

These figures, when compared with the preceding table, indicate a decided falling off in the growth of the unfertilized trees, especially in the uncultivated plat. On the fertilized plats a part of this falling off in wood growth is of course due to the fact of the annual crops of fruit which have been produced. This reason is less applicable to the unfertilized trees, as they have borne less regularly. The low average growth of Gravenstein on the cultivated area as compared with the mulched trees, is due to the injury to some of the trees, as before mentioned. In the absence of injury, which was an individual matter, the cultivated trees made a larger growth than the others, as may be seen by referring to the tables on pages 185 and 186.

THE QUESTION OF YIELDS.

In 1902, the first bearing year of this young orchard, the following results—irrespective of fertilizers—were obtained:

Gravenstein—Cultivated, 19 bearing trees, averaging .72 bbl. per tree; mulched, 14 bearing trees, averaging .59 bbl. per tree.

Tolman—Cultivated, 9 bearing trees, averaging .44 bbl. per tree; mulched, 6 bearing trees, averaging .50 bbl. per tree.

In case of the Gravenstein, there was a decided difference both in number of bearing trees and in average yield per tree in favor of cultivation. With the Tolman the difference was less marked.

It is planned to keep an exact record of the yield of each tree in the orchard every year. By accident, however, the records of the Gravensteins were unsatisfactory for a part of the time, and there is given below only the record of the Tolmans.

Cultivation vs. Mulch—Annual Yields.

Number of tree.		1902.	1903.*	1904.	1905.	Remarks.
				Bush.	Bush.	
	CULTIVATED.					
13	Good			3.0	2.0	
14	Good			2.8	6.5	
15	Small			1.0	2.4	
16				0.5	1.9	
17	Medium			1.8	4.0	
18	Medium			2.0	7.0	
19	Small			1.2	2.5	
20	Small			.5	4.8	
21	Full			4.0	5.0	Extra; both tree and fruit.
22	Full					Dead.
23	Small			1.3	7.6	
24	Small			.3	.0	
	Total			18.4	43.7	
	MULCHED.					
53	Small			.8	4.5	
54				.0	0.0	
55				1.2	2.5	
56				3.0	4.2	
57	Small			Full	Medium	Bellflower.
58				5.0	2.5	
59				1.8	1.7	
60	Medium			1.8	3.0	
61	Medium			2.6	2.2	
62				1.0	3.2	
63	Small			3.5	3.2	
64	Small			1.3	4.0	
	Total			22.0	31.0	

* By an accident the records of 1903 were rendered useless and are omitted. There was a fair crop on most of the trees.

With the exception noted, the above trees are now all in prime bearing condition and yield satisfactory annual crops. In Bulletin 89 the statement was made that, "With Tolman the number of bearing trees is greater by one-half on the cultivated area, but the average yield is slightly less. Most of the fruit on the cultivated area came from four trees; the remaining trees, in most cases, not having half a peck each." The same general ratio existed for the next two years. In 1904 the total yield from eleven trees on the cultivated plat, as shown by the table, was 18.4 bushels, or an average of 1.7 bushels per tree; while on the mulched area, for the same number of trees, the total yield was 22 bushels, or an average of 2 bushels per tree.

In 1905, however, the relative advantage of cultivation becomes evident when it appears that there is a total of 43.7

bushels, or an average of 4 bushels per tree on the cultivated trees, as compared with 31 bushels, or an average of 2.8 bushels per tree where mulching was used.

By reference to the diagram of the orchard, page 183, it may be seen that much better returns have, as a rule, been obtained from those trees upon which stable manure has been used. For example, trees 13, 14, 17, 18, 21 and 22, on the cultivated plat, received stable manure and produced an average of 2.7 bushels per tree in 1904, and 4.9 bushels in 1905; while the others, receiving commercial fertilizers, gave an average of .8 and 3.4 bushels for the two years respectively. On the mulched area similar results followed. Trees 55, 56, 59, 60, 63 and 64, received stable manure and gave an average of 2.1 and 3.1 bushels for the two years; while the other trees, receiving commercial fertilizer, yielded an average of 1.9 and 2.5 for the two years. These facts are given without further comment. Future management of the orchard will of course be governed by the lessons learned.

The Potash Orchard.

The study of the specific influence of different potash salts upon the apple is continued as in former years. The treatment is as detailed in Bulletin 89; but the need of additional nitrogen being evidenced by the growth of the trees, an application of 350 pounds per acre of nitrate of soda, and of about 650 pounds per acre of acid phosphate was made in 1904, besides the usual excessive application of potash salts. The season being very dry, the trees did not profit much by this application and it was repeated in 1905, with marked advantage.

The severe winter of 1904-5 worked serious injury to some of the trees but as a result of the fertilizing and the cultivation given, most of them have started a vigorous new growth, and fruit buds are well developed for next year.

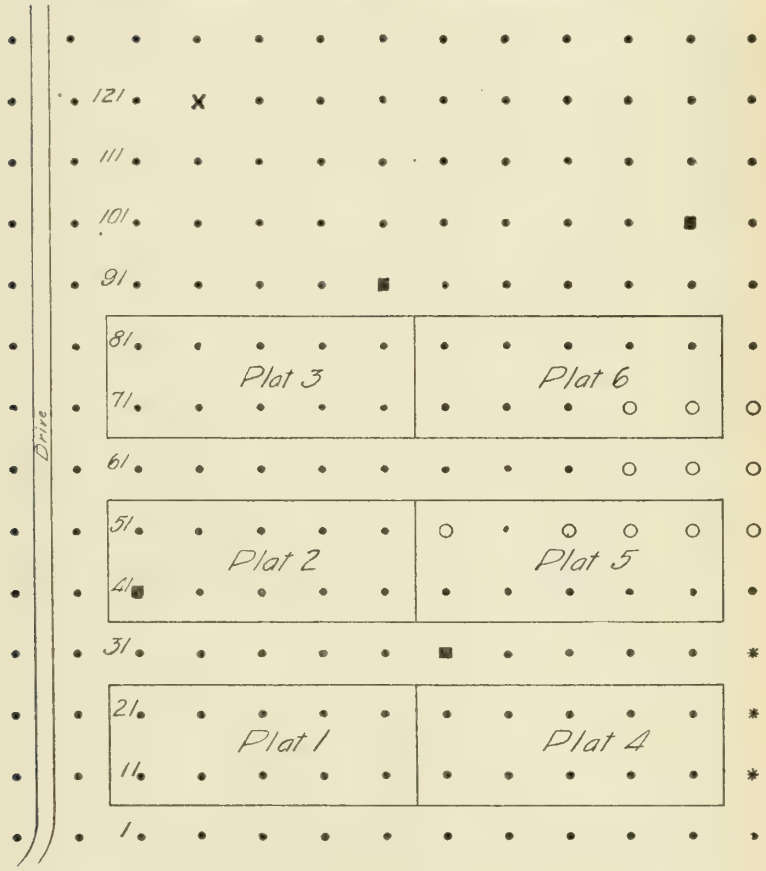
Without going into details at this time, it may be said that there is no noticeable difference in the character of fruit or of the behaviour of the trees as a result of the form of potash used. The work will be continued further, however.

Orchard Renovation.

In 1902, because of the manifestly favorable results following the treatment given the orchards above referred to, one hundred

trees were set apart for specific experiments in the renovation of an old orchard. The trees in question were about thirty-five years old, planted on the western slope of a dry gravelly hillside. They were divided into six groups, with appropriate check trees, as indicated in the accompanying diagram.

ORCHARD RENOVATION.—DIAGRAM OF THE ORCHARD.



TREATMENT OF THE ORCHARD.

The history of the orchard, as given in Bulletin 89, is as follows: "The soil is a light sandy loam, 6-8 inches deep, with gravelly or sandy subsoil. The trees were set in 1866-70 in a cultivated field which had previously produced corn, wheat, and

general farm crops; but after a very few years the orchard was used as a sheep pasture, the trees being frequently mulched while young. No further attention was given the trees, save an occasional slight pruning, until May, 1892, when the whole orchard received an application of bone and muriate of potash. The same summer hogs were turned in, and they thoroughly stirred the soil and started the trees into vigorous growth. A very large crop of fruit was produced in 1893 and again in 1896, but since that date the trees have done practically nothing. Since 1892 the orchard has received no treatment except spraying, until the present year when a portion of it, as indicated in the diagram, was thoroughly tilled and variously fertilized."

The fertilizers used in 1902, 1903 and 1904 were as follows:

Plat 1—Muriate of potash 75 lbs; acid rock 75 lbs; nitrate of soda 50 lbs.

Plat 2—Muriate of potash 75 lbs; acid rock 75 lbs.

Plat 3—Nitrate of soda 50 lbs; acid rock 75 lbs.

Plat 4—Acid rock 75 lbs.

Plat 5—Muriate of potash 75 lbs.

Plat 6—Nitrate of soda 50 lbs.

In 1905 the same materials were used, but only two-thirds the amount of each.

The orchard has been plowed every spring and harrowed at intervals during the summer. The effects of the culture and feeding are evident as far as the orchard can be seen from surrounding hilltops; and the satisfactory annual crops of fruit more than illustrate the practical importance of systematic orchard management.

RESULTS OF TREATMENT.

At the close of the first season's treatment it was stated (see Bulletin 89, p. 19): "As might be expected, the plat receiving a complete fertilizer presented the best appearance at the end of the growing season. The use of nitrogen alone increased the growth to a marked degree (though less than the complete fertilizer) but there was a noticeable lack of color in the fruit. Trees on the plat receiving acid rock alone, in general, seemed no better than the check trees which were cultivated but not fertilized. Potash alone, on the other hand, produced a distinct improvement."

These impressions have been confirmed by the work of succeeding years, particularly as to the effect of the complete fertilizer and the nitrogen. The lack of color upon the fruit from trees receiving an excess of nitrogen is specially noticeable.

In 1904 a very serious injury to both tree and fruit was apparently the result of a too free use of nitrogen, either alone or in the absence of potash. The foliage dropped, the fruit cracked, and much of it dropped, while the remainder was as soft and mealy in October as it should have been the following May. This is referred to in another connection.

YIELD OF FRUIT—RENOVATED ORCHARD.

Since the first year of treatment, this orchard has made a good growth and has yielded annual returns of fruit. Not every tree has borne every year, for there is a decided individuality among trees given precisely the same treatment; but from the record of fruiting given below it is evident that the so-called "off year" in case of the Baldwin is an unnecessary condition,—a condition which the up-to-date orchardist will not permit to exist.

Without attempting to draw conclusions, at present, there are certain interesting facts brought out by the tables on pages 194 and 195. The best general results are seen to follow on plat 1, complete fertilizer; but there are notably good individual trees upon the other plats (see figure 10) and among the check trees. Taking at random some of the trees in the orchard, it will be seen that tree 11 in 1903 produced 4.5 barrels of fruit; in 1904, 1 barrel; in 1905, 2.8 barrels. Tree 25 produced 8.5, 4, and 5.8 barrels for the three years respectively. Tree 53 gave 5, 2.7 and 3.3 barrels, and so on. On the other hand, tree 43 has a record for the three years of 0, .7 and 0. Tree 75 is gradually improving, the record for the three years being 0, .8 and 1 barrel, respectively.

The check trees adjoining plats III and VI are noticeably productive; which fact may be due to sending their roots across into the adjacent plats.

Certain of the trees have been indicated as being of specially good type; these are watched from year to year to see if the character is permanent. If so, these trees become specially valuable as a source from which to obtain cions in top-working a young orchard.

These notes are to be regarded more as a report of progress than as data from which to draw definite conclusions.

Orchard Renovation—Annual Yield.

Plat and number of tree.	Yield per Tree, in Barrels.			Remarks.
	1903.	1904.	1905.	
Plat I.				
Tree No.				
11	4.5	1.0	2.8	
12	3.5	0.0	2.6	
13	3.5	3.3	2.4	
14	2.0	3.0	3.4	
15	6.5	1.7	3.0	
21	3.0	2.8	1.9	
22	3.0	6.0	1.0	
23	4.0	1.6	3.2*	*Extra good fruit, 1905.
24	.5	3.0	.6	
25	8.5	4.0*	4.8*	*Extra good fruit.
Check Row				
Tree No.				
31	3.5	6.1	.1	
32	5.0	3.9	2.1	
33	1.5	2.0*	2.1	* Extra good type.
34	1.5	4.2	0.0	
35	1.5	1.7*	1.5	* Extra good type.
Plat II.				
Tree No.				
41	.....	.....	.....	Vacant.
42	3.0	8.7	0.0	
43	0.0	2.5	0.0	
44	3.5	4.1	0.0	
45	1.0	5.4	1.2	
51	4.5	5.9*	2.4*	* Extra good type of fruit.
52	1.0	3.4	0.0	
53	5.0	2.7*	3.3	* Extra good type.
54	.5	4.7	0.0	
55	.5	3.7	.1	
Check Row				
Tree No.				
61	.....	1.5	0.0	
62	2.5	3.8	0.0	
63	1.0	4.5	.1	
64	1.0	6.4	0.0	
65	2.0	4.0	0.0	
Plat III.				
Tree No.				
71	5.5	.4	2.1	
72	6.5	.0	3.4	
73	1.5	.4	1.7	
74	1.0	1.5	.5	
75	0.0	.8	1.0	
81	6.0	2.9 †	1.5	† Nearly all the fruit on this plat dropped early, in 1904, remainder was soft and worthless as in April or May.
82	2.5	1.0	3.2	
83	3.5	1.5	2.6	
84	4.0	.9	4.8	
85	4.0	1.1	4.1	
Check Row				
Tree No.				
91	.....	3.5	.6	
92	.....	1.8	.5	
93	.....	3.0	2.3	
94	.....	5.4	3.6	
95	.....	4.1	.....	

Orchard Renovation—Annual Yield—Concluded.

Plat and number of tree.	Yield per tree, in barrels.			Remarks.
	1903.	1904.	1905.	
Plat IV.				
Tree No.				
16	1.5	1.3	1.0	
17	2.0	6.5*	.5	* Extra good type.
18	.0	.4	.9	
19	0.0	2.5	.7	
20	7.0	5.8*	1.3	* Extra good type.
26	..0	2.5	.1	
27	1.5	5.0	1.9	
28	.0	3.7	.4	
29	.0	5.1	2.3	
30	4.0	2.4	3.4	
Check Row				
Tree No.				
36	.....	.....	.....	Vacant.
37	.0	5.0	.2	
38	.0	2.4	1.0	
39	.0	5.8	.3	
40	.0	.4	.1	Almost dead.
Plat V.				
Tree No.				
46	2.0	4.2	.0	
47	5.0	5.8	3.4	
48	.0	2.2	1.6	
49	.0	2.5	1.2	
50	.0	1.8	1.0	
56	.....	.....	.....	Gravenstein.
57	.0	.0	.9	Tree broken; only one limb, extra fine fruit.
58	.....	.....	.....	Gravenstein.
59	.....	.....	.....	Gravenstein.
60	.....	.....	.....	Gravenstein.
Check Row				
Tree No.				
66	1.5	2.4	1.6	
67	2.0	2.3	.8	
68	2.5	1.3	.2	
69	.....	.....	.....	Gravenstein.
70	.....	.....	.....	Gravenstein.
Plat VI.				
Tree No.				
76	3.0	1.0	1.0	
77	6.5	0.0	1.3	
78	.0	.0	.1	
79	.....	.....	.....	Gravenstein.
80	.....	.....	.....	Gravenstein.
86	3.0	.7	1.6*	* Also .8 bbl. Starkey on portion of tree.
87	4.0	.0	2.8	
88	3.5	2.8	3.5	† Condition of this fruit similar to that of plat 3.
89	.0	1.1	.5	
90	1.0	3.2	.9	
Check Row				
Tree No.				
96	.....	7.0	.0	
97	.....	2.6	1.0	
98	.....	3.4*	2.0	*Extra good fruit.
99	.....	.5	1.0	
100	.....	4.2	1.1	

The Fisher Formula.

In response to a demand for definite information as to the merits of a highly nitrogenous fertilizer made after what is known as the "Fisher formula," and used quite extensively in some parts of the State, a comparison of this fertilizer with one commonly recommended by the writer for orchard purposes has been undertaken.

Briefly stated, the Fisher formula—so called because first suggested by Dr. Fisher of Massachusetts—is composed of about 8.6 per cent nitrogen, 3.3 per cent phosphoric acid and 11.9 per cent of potash, being made up as follows: Nitrate of soda, 350 lbs; sulphate of ammonia, 150 lbs; sulphate of potash, 230 lbs; acid phosphate, 200 lbs; kieserite, 50 lb. "All to be thoroughly mixed and sown on the surface under the tree out a little further than the limbs extend, at the rate of ten pounds to a medium sized tree, from the first to the tenth of May, or as soon as the blossom buds begin to open."

Unquestionably this fertilizer produces a most vigorous growth, resulting in large, though not always well colored fruit, and on uncultivated land it is regarded with favor by many growers. For use in connection with the thorough cultivation now recommended, however, the percentage of nitrogen is too high for the best results.

The Station formula contains about 3 per cent nitrogen, 5½ per cent phosphoric acid and 8 per cent potash, being made up as follows: 200 lbs nitrate of soda; 75 lbs sulphate of ammonia; 225 lbs muriate of potash; 500 lbs acid phosphate.

The cost of this fertilizer is about $16 per 1,000 pounds; that of Fisher fertilizer about $21 per 1,000 pounds for the materials alone.

Twenty Baldwin and five Tolman trees are being used for the specific test of each of these formulas. The Baldwins are kept under cultivation; the Tolmans are in sod. The work has been in progress for two seasons, which time is of course not sufficient to warrant conclusions. It may be said, however, that both lots of trees have responded freely to the treatment, and yielded a good crop of fruit this year. The Baldwins were in an exhausted condition when the work was commenced, but all are now making a remarkably strong, vigorous growth, and promise

well. It should be said, however, that as in the experiments first mentioned, the stirring of the soil, and the decay of the turf in case of the cultivated trees, obscures any specific difference in the relative merits of the two formulas up to the present time.

The following diagrams represent the orchards now under observation:

FISHER FORMULA—DIAGRAM OF BALDWIN ORCHARD.

1 □	2 □	3 □	4 □	5 □	6 □	7 □	8 □
9 □	10 □	11 □	12 □	13 □	14 □	15 □	16 □
17 •	18 •	19 •	20 •	21 •	22 •	23 •	24 •
25 ⊙	26 ⊙	27 ⊙	28 ⊙	29 ⊙	30 ⊙	31 ⊙	32 ⊙
33 ⊙	34 ⊙	35 ⊙	36 ⊙	37 ⊙	38 ⊙	39 ⊙	40 ⊙

FISHER FORMULA—DIAGRAM OF TOLMAN ORCHARD.

1 •	2 •	3 •	4 □	5 □	6 ⊙	7 •
8 •	9 •	10 •	11 ⊙	12 □	13 ⊙	14 •
15 ×	16 •	17 •	18 •	19 □	20 ⊙	21 •

EXPLANATION OF DIAGRAM. □—Station formula; ⊙—Fisher formula; •—untreated tree; ×—vacancy.

The Top-Working of Orchards.

The experiments here noted include the relative value of cions from bearing trees of known value as compared with cions from miscellaneous sources; the actual commercial advantage, if any, of changing vigorous trees from Ben Davis to Baldwin, Sutton, Spitzenburg, or Jonathan; and incidentally the question as to the value of Ben Davis as a stock for top-working.

PLAN OF WORK.

Adjacent trees (three of each) were top-grafted April 8, 1904, with cions from nursery trees and from bearing trees, as shown by the map on page 199. The "nursery cions" were obtained from H. S. Wiley, Cayuga, N. Y.; the "fruiting tree cions," from Geo. T. Powell, Ghent, N. Y. (except Baldwin which were from Mr. Pope's orchard). As a check upon this work, and to see if it really pays to top-work a young orchard of this kind, four of the original Ben Davis trees are left (Nos. 7, 8, 26 and 27). These are to be pruned and cared for the same as the top-worked trees.

HISTORY AND CONDITIONS OF THE ORCHARD.

The orchard was set (two-year-old trees) in May, 1890. The trees were cultivated the first year. After that, however, they were left in sod and hay was cut every year until 1902 when hogs were turned in for one season. No treatment of any kind was given in 1903, and a good crop of fruit was produced. Trees made an excellent growth in 1902 and 1903, and the north half of the orchard is in good condition. About the middle of the plat the water has stood some in winter and trees have suffered.

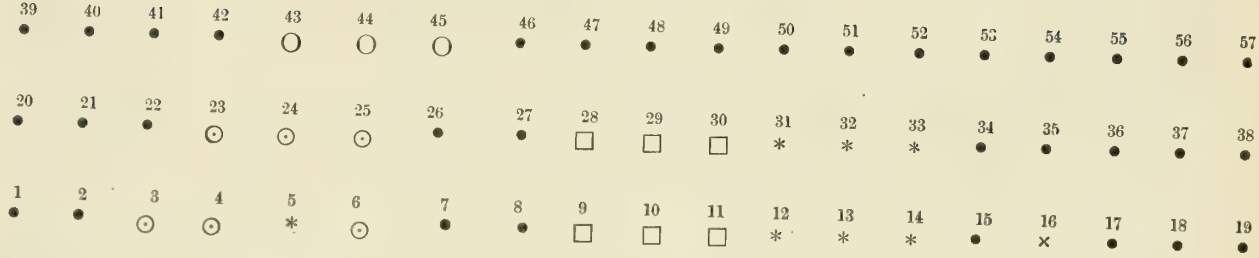
With the exception of tree No. 14, the trees which were top-worked in 1904 were in good vigorous condition.

1904. Orchard plowed and cultivated during summer. Five hundred pounds of fertilizer analyzing about 3 per cent nitrogen, 6 per cent phosphoric acid, and 8 per cent potash. Photographs made at time of grafting.

1905. Treatment of previous year repeated. Superb growth,—15 to 24 inches. Photographs made October 23.

Naturally conclusions are not yet drawn from this work.

DIAGRAM OF TOP-WORKED ORCHARD.



EXPLANATION OF DIAGRAM: The significance of the characters in the above diagram is as follows: •—Ben Davis, original trees; ⊙—Baldwin; ▪—Sutton; *—Jonathan; O—Spitzenburg; ×—vacancy.

All cions used in the first row were from nursery trees; all cions in the second row from bearing trees. The Spitzenburg cions in third row, from bearing trees

Keeping Qualities as Affected by Culture.

The influence of cultivation in an orchard, as affecting the keeping quality of the fruit, is a question of perennial interest. The Station has no facilities for conducting a satisfactory inquiry in this direction, but as bearing upon the subject several barrels of fruit were set aside in the winter of 1904-5 in Mr. Pope's cellar, and were left until some time after the usual season for marketing. While conclusions can not be drawn from this test, certain indications may be suggestive.

For the trial three barrels of Tolmans and four barrels of Baldwins were set aside. Of the Tolmans, one barrel each from sod and from cultivated land were taken, and one barrel was divided between the two. Of the Baldwins, two barrels were from trees in sod and two from adjacent cultivated trees. The fruit was sorted as for commercial purposes and the barrels were headed up and set in a very cool cellar, in a temperature of 35 to 40 degrees Fahrenheit.

On April 7 the Tolmans were examined and showed signs of breaking down. They were accordingly assorted and a record made of their condition. At this time the Baldwins showed no sign of breaking down, and they were left until May 10 before assorting. In each case the fruit was divided into three classes: (1) that which was perfectly sound; (2) slightly decayed, or "specked," including that form of breaking down commonly called "scalding;" (3) decayed or worthless fruit. The following table represents the exact condition of the fruit at the times indicated:

Variety.	Number fruits sound.	Number fruits specked.	Number fruits decayed.	Total number fruits.	Per cent sound.	Remarks.
Tolman						
No. 1 (sod)	344	102	48	494	69.6	Free from scald and of better color than cultivated fruit—often with blush.
No. 2 (sod)	164	27	21	212	77.4	
No. 3 (cultivated)	314	140	27	481	65.3	A little scald.
No. 4 (cultivated)	222	45	15	282	78.7	Much scald.
Baldwin						
No. 1 (sod)	655	83	14	752	87.1	Sod grown fruit scalded worse than the other but was of better color.
No. 2 (sod)	507	196	25	758	66.9	
No. 3 (cultivated)	438	125	120	683	64.1	
No. 4 (cultivated)	361	183	51	595	60.7	

These figures seem to contradict, or at least to cast doubt upon the statement frequently made by some of the best writers upon fruit growing, viz.: "Apples grown in sod attain a higher color and keep longer than those grown under clean culture."

There is no uniformity in the results shown. For instance, of the Tolmans the barrel from sod land gave 69.6 per cent of sound fruit at the end of six months; while the corresponding barrel from cultivated land gave 65.3 per cent—a difference of only 20 apples in the barrel, and the actual number of worthless fruits was nearly double from the sod grown tree. Where the fruit was in the same barrel (numbers 2 and 4 of Tolman), the difference was 1.3 per cent in favor of the cultivated fruit. Of the Baldwins, one barrel was decidedly better than all of the others, and both barrels from sod land gave a higher percentage than did those from cultivated land; but the difference between number 2 and numbers 3 and 4 was not greater than might be expected from fruit grown under the same conditions. Indeed not so great as the difference between numbers 1 and 2.

The color of the fruit grown on sod was usually better than that from the cultivated trees; but the size of the other fruit was greater. In order to be of permanent value these tests should be made under the best conditions for a series of years, and with a wide range of varieties.

Cover Crops.

While no data are to be reported at this time, the importance of a winter cover for orchard lands that are given clean culture during the summer should not be overlooked. In brief, the practice followed by the writer is to plow the orchard in May, cultivate freely and frequently until about the first to the tenth of August and at the last cultivation seed the ground with some crop which shall make an effective cover through the winter and during the period of freezing and thawing, the following spring.

ADVANTAGES OF A COVER CROP.

The advantages following the use of a cover crop may be summarized as follows:

(1) The cover crop utilizes soluble fertilizers which would otherwise be wasted, and prevents washing of the land.

(2) Adds humus to the soil.

(3) Protects roots during winter, and holds the snow.

(4) Helps to dry out the soil in spring, thus permitting earlier working of the land.

(5) In some cases adds directly to the store of nitrogen in the soil,—as when leguminous crops are used.

(6) Growth of trees late in the season is checked.

KIND OF COVER CROP.

What to sow for a cover crop depends largely upon soil and location. On good strong land, which is not specially in need of additional nitrogen, winter rye has proved the most satisfactory of anything tried at the Station. It germinates quickly, and even in cold seasons, when frosts come early, will form a very satisfactory mat before winter. On "thin" soils, however, rye does not stool freely and fails to make a good cover. Such soils also are usually in need of more nitrogen and will be benefited by the use of some leguminous crop like the vetches or mammoth clover. The ideal cover crop on such soils is winter vetch (*Vicia villosa*), sown as early as July 15. Within six weeks this plant develops nitrogen accumulating nodules and contributes directly to the fertility of the land. It is hardy and usually makes a good growth the following spring before time for plowing.

Spring vetch (*Vicia sativa*), is another nitrogen gathering cover crop which makes a very vigorous growth in the fall, often forming a perfect mat a foot thick, when sown August 1. It is apparently even more efficient than the winter vetch as a nitrogen gatherer, but it does not survive the winter; hence is not as valuable in preventing washing by the spring rains, and does not help dry out the land in spring.

Mammoth clover must be sown as early as July 15 to produce sufficient growth to be of much value. As a rule the vetches are to be preferred.

Other crops used at the Station for this purpose are peas, oats, and these two combined. All things considered, however, the first three mentioned are the most satisfactory.

A WORD OF CAUTION.

While in general the use of a cover crop in cultivated orchards is advantageous, there are cases where, if used injudiciously, it

may be actually detrimental. One such case is the use of rye upon a soil naturally dry and gravelly; especially if the crop is left late in spring before plowing under. This treatment may result in so drying the soil as to seriously interfere with the growth of the trees. On soils of the nature indicated, spring vetch or oats are always to be preferred unless the land is to be plowed promptly in the spring.

Orchard Work at New Gloucester.

For the purpose of emphasizing the importance of rational treatment of orchard lands in other sections of the State, arrangements have been made with Mr. John W. True and Mr. Fred H. Chandler of New Gloucester to carry on certain coöperative experiments in the planting and management of orchards.

The work in Mr. True's orchard includes the use of cover crops and a comparison of the Fisher formula with the Station formula and with stable manure. For the latter work an orchard of Baldwins, set about 20 years and sadly in need of pruning, was selected. The orchard was pruned and plowed, and fertilizers were applied as follows: 4 rows were given stable manure; 5 rows Station fertilizer; 4 rows Fisher fertilizer; with a check row between each two plats. For the study of cover crops, a two-acre orchard of Ben Davis and a one-acre orchard of Sutton, both just coming into bearing, are available. The crops thus far used are rye and winter vetch, but of course only a report of progress can as yet be made concerning either line of work indicated.

The work in Mr. Chandler's orchard contemplates a study of different methods of orchard treatment and some of the problems connected with the top-grafting of orchards. About eight acres of rolling land, in plain sight from the Maine Central Railroad station at New Gloucester, were fitted and planted to various trees in the spring of 1905. The land is mostly a strong loam, with heavier subsoil, and had been in hay for several years. The ground was plowed the first week in May and, after harrowing, the trees were set two rods apart each way. Between the first five rows, and alternating with the trees in those rows, (thus making a "quincunx" planting) "fillers" of Wealthy were planted. In 1906 the planting of "fillers" will be extended.

Strong two-year old trees of the following varieties were used: Northern Spy, Ben Davis, Tolman, and Wealthy. Most of these, except the Wealthy "fillers," will eventually be top-grafted to Baldwin.

Careful maps and records have been made and reports of progress will be made later. During the past season the orchard between the trees was planted to corn, peas and potatoes. It is designed to keep the greater part of the orchard under cultivation each year.